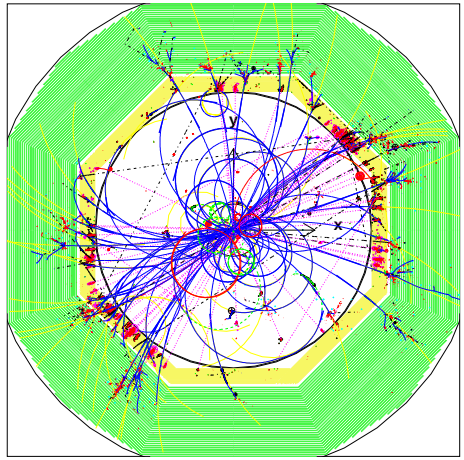
Inside view on LC calorimeters!

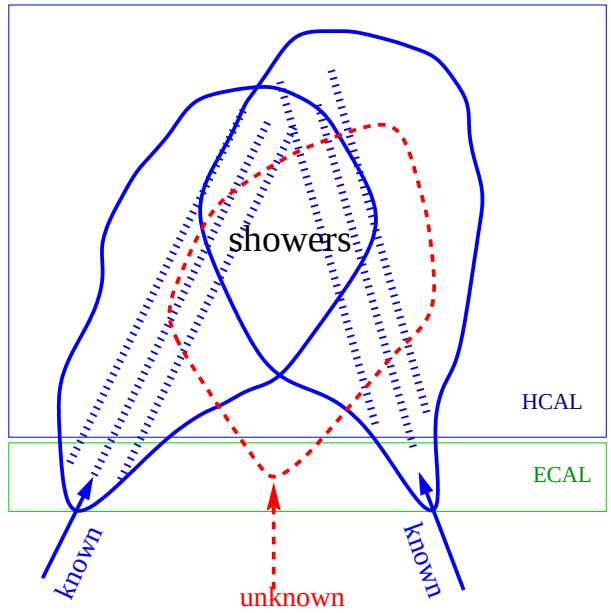
track extrapolation onto the inner calorimeter face —
implications for calorimeter design?



plots taken from the TESLA Technical Design Report and/or Vassili Morgunov, DESY/ITEP Moscow

Motivation: particle flow

(the concept formerly known as "energy flow")

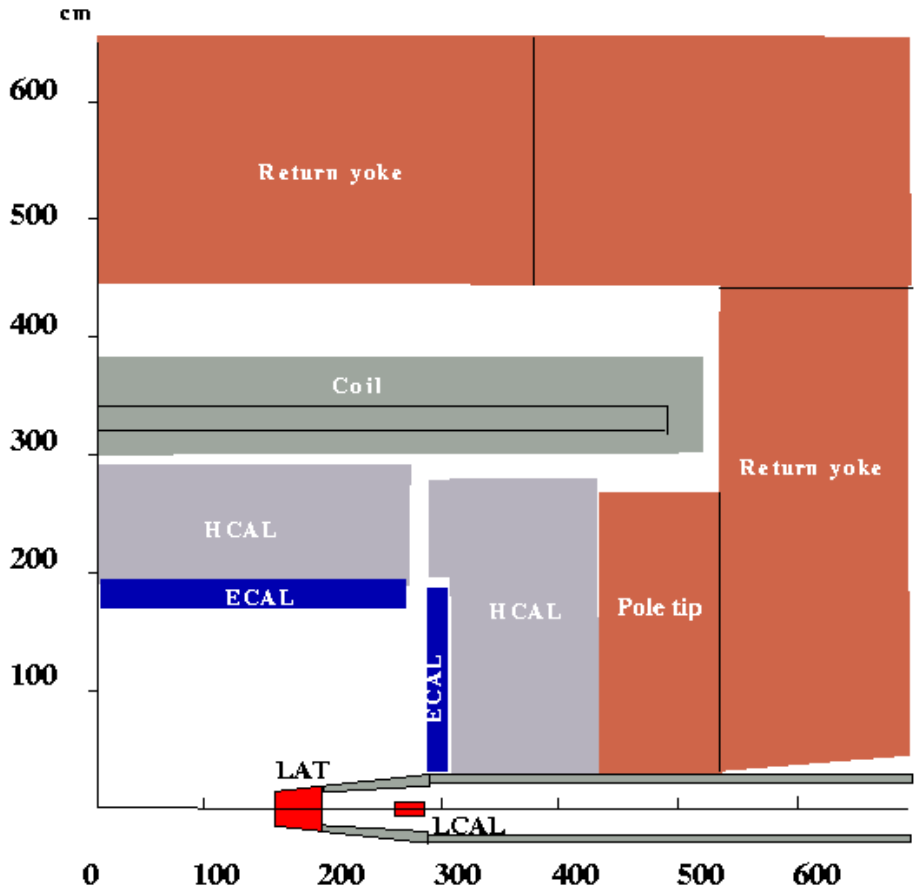


need excellent matching of tracks with calorimeter information!

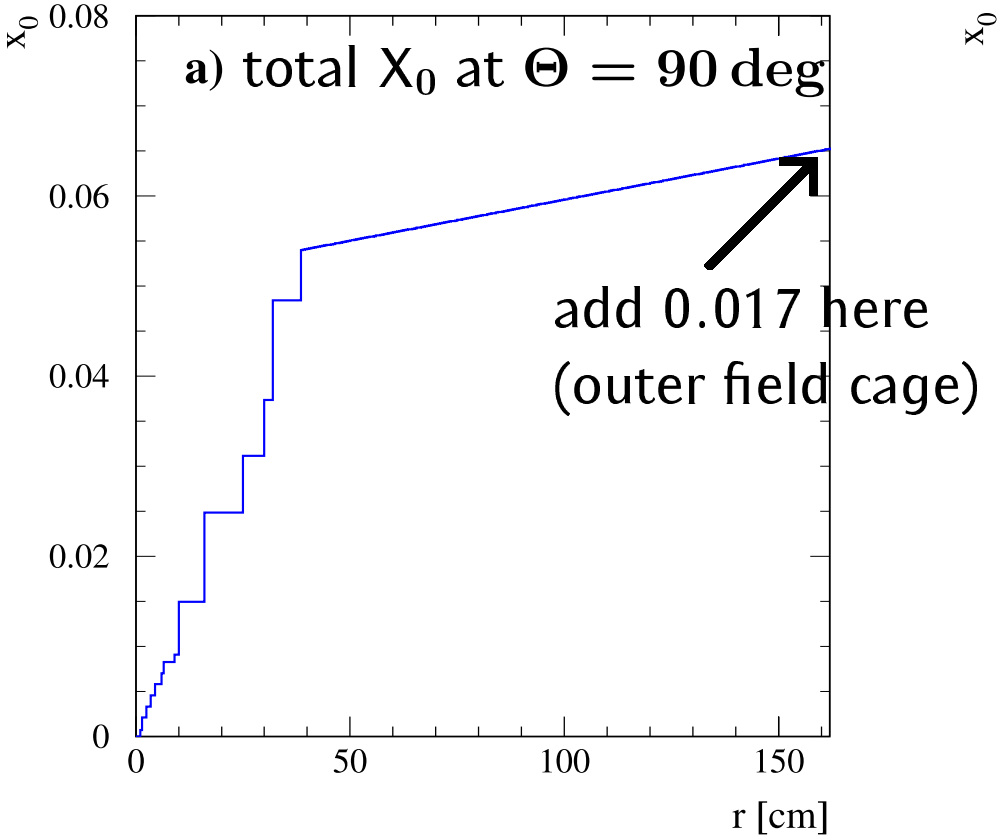
Detector configuration (TESLA detector)

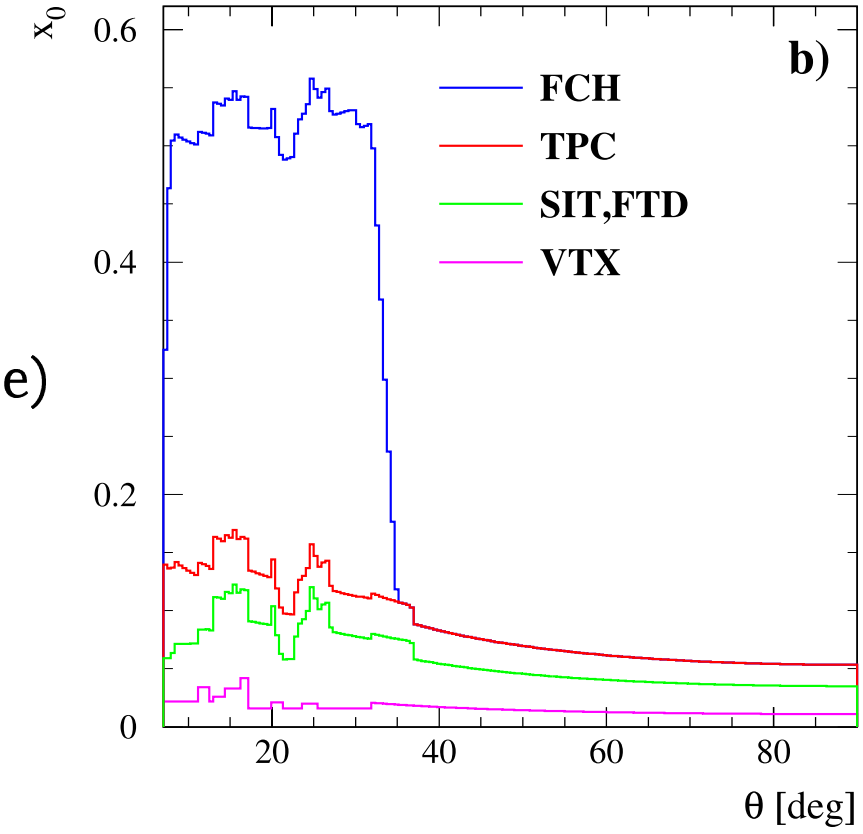
Reduce material in front of calorimeters ➡ improved energy resolution

- coil outside calorimeters
- tracking detectors optimized for less material



Material budget of tracking detectors





main contributions:
TPC endcaps, vertex detector cryostat, TPC field cages

Impact on particle flow

rather general problems for reconstruction:

- showering, secondaries (not discussed here)

specific problems for merging of tracker/calorimeter information:

need precise reconstruction of charged particle trajectory at impact on calorimeter face

- energy loss shifts predicted impact position wrt. helix extrapolation
- multiple scattering shifts impact position and flight direction
- limited single hit resolution of tracker $\longrightarrow$ intrinsic limits to precision

How significant are all these effects?

Work to be done

How significant are all these effects?

finding a detailed answer is a *very* sophisticated task:

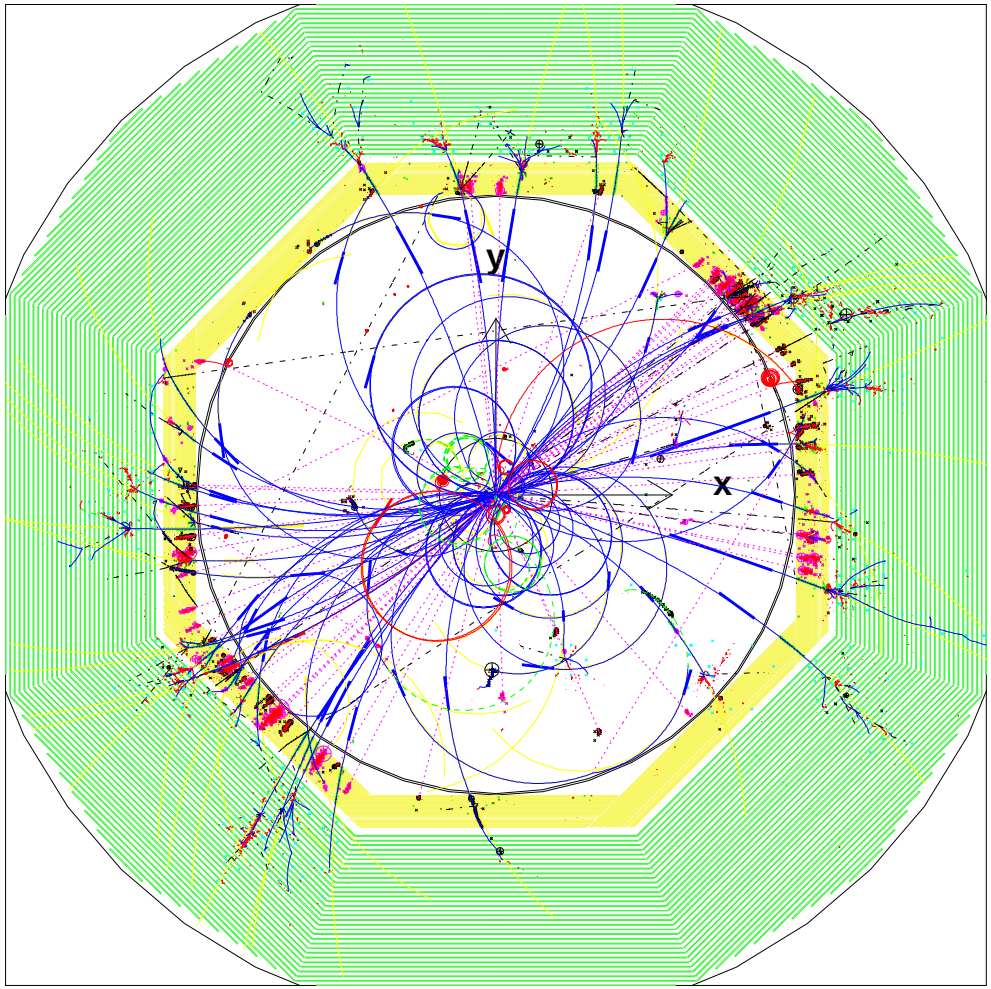
- requires full detector simulation with energy loss and scattering
- requires realistic reconstruction algorithms
  for calorimeter and tracker

twofold impact on calorimeter design

- direct
  (what shower origin resolution is adequate to match trackers?)
- indirect
  (determination of expected performance requires good and realistic reconstruction of simulated events)

studies for TESLA TDR calorimeters by V. Morgunov; tracking interface: my contrib.

$t\bar{t}$ event at $\sqrt{s}$=350 GeV in TESLA detector



blue = reconstructed tracks
yellow = extrapolation into calorimeter
red, green = tracks not reconstructed
magenta, black = neutral particles

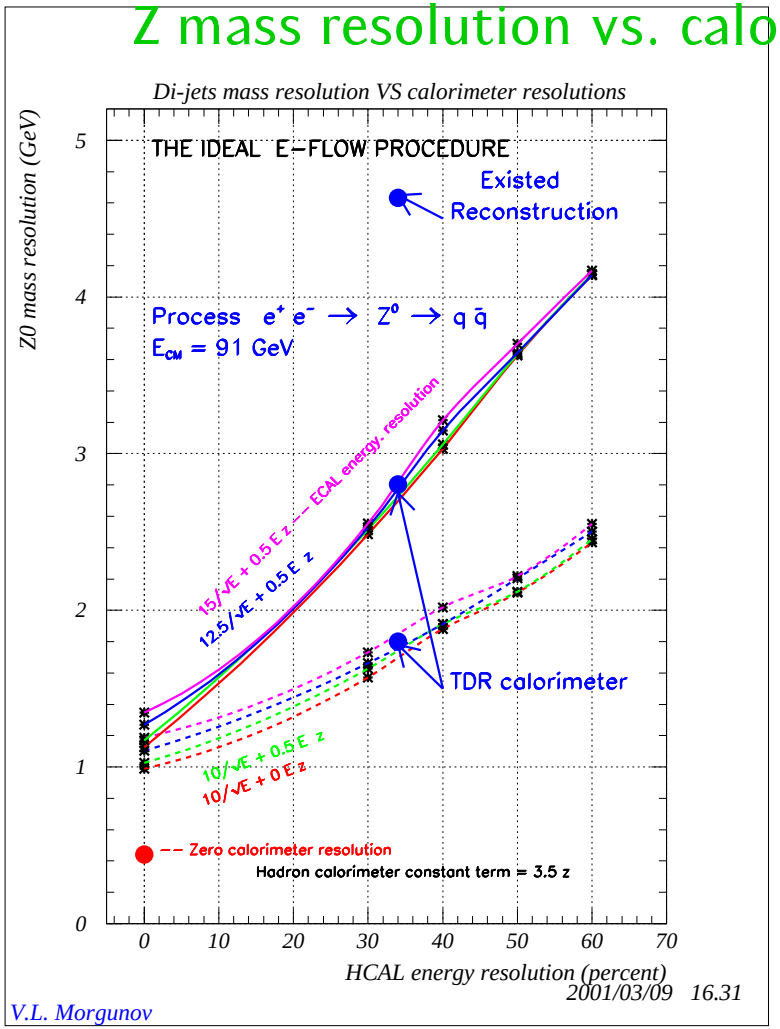
particle flow reconstruction performance easily spoiled in jet environment if design and/or reconstruction not done carefully!

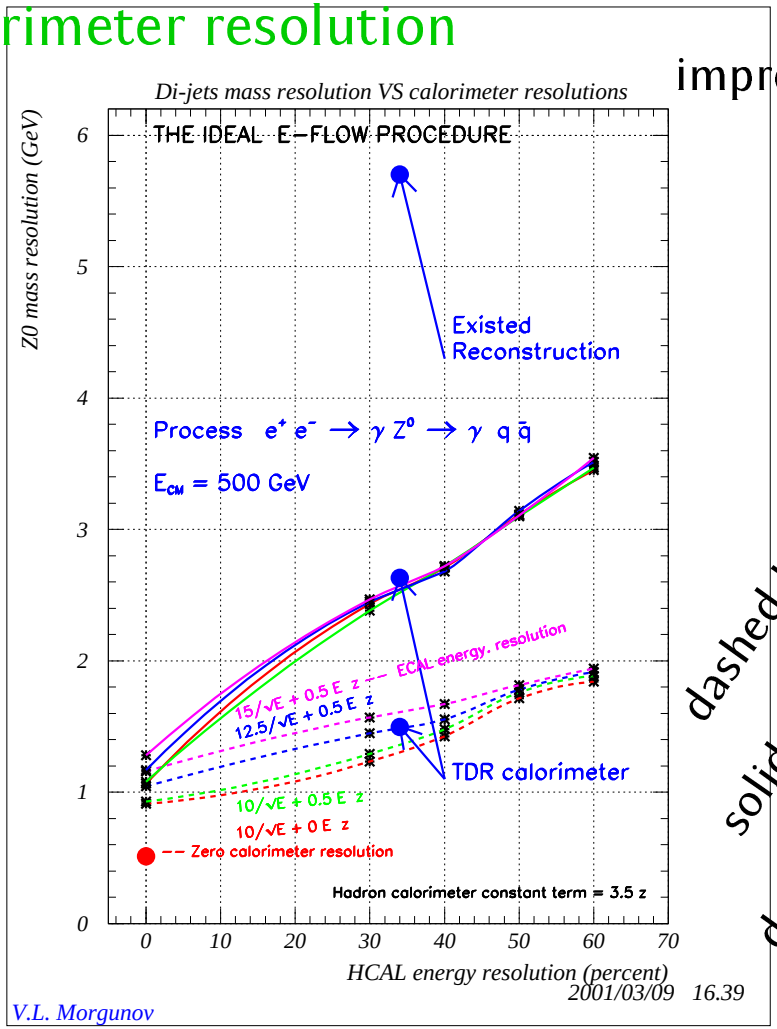
Track extrapolation to calorimeter surface

a few numbers and plots:
— energy loss for pions between production and calorimeter
— shift of impact point in rphi and z with respect to helix
— resolution of track parameters at impact

Impact on overall performance

Z mass resolution vs. calorimeter resolution





status as of 2001
improvements since ther

dashed line: ideal reconstruction
solid line: ideal track rec, real calo rec
dot: real track rec, real calo rec

Conclusion

Interface of tracking and calorimetric detectors:
huge impact on overall detector performance!

- Merging of track information has to be done carefully
- Design of calorimeters has to take tracking into account!

Detailed studies (to my knowledge) only for TESLA TDR design.
Even this is far from being complete.